

Advanced Control Method for Hypersonic Vehicles

Completed Technology Project (2013 - 2015)



Project Introduction

This research effort aims to develop software control algorithms that will correct for roll reversal before it happens. Roll reversal occurs when an aircraft is steered in one direction but rolls the opposite way due to aerodynamic conditions. The problem often compounds as a pilot attempts to correct for the motion by over-steering in the original direction, leading to uncontrollable roll. Unexpected yaw and subsequent roll reversal has caused the loss of high-speed, lifting body-like vehicles. The team has employed novel predictive software within adaptive controller technology to detect conditions likely to result in aircraft roll reversal and then automate compensating maneuvers to avoid catastrophic loss.

Work completed: University of Michigan's retrospective cost model refinement (RCMR) control algorithm has been integrated into a flight simulator and tested with prerecorded, open-source parameter data, which replicates the roll reversal anomaly.

Looking ahead: Next steps involve upgrading the RCMR code to account for a six-degree-of-simulation environment (forward/back, up/ down, left/right, pitch, yaw, and roll) with eventual application in a flight test environment.

Partners: University of Michigan, other government research agencies, and aerospace firms.

Benefits

- **Operates independently:** Unlike other standard control systems, this method allows for compensation and control of aircraft roll reversal without *a priori* knowledge of the dynamics.
- **Improves safety:** This technology is expected to prevent crashes that occur due to uncontrolled roll.
- **Increases envelope:** RCMR would enable planes to travel safely over a larger envelope.

Applications

- Hypersonic jets
- Lifting body-type space vehicles and reentry vehicles

Anticipated Benefits

- **Operates independently:** Unlike other standard control systems, this method allows for compensation and control of aircraft roll reversal without *a priori* knowledge of the dynamics.
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- **Increases envelope:** RCMR would enable planes to travel safely over a larger envelope.



Vehicle Model

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

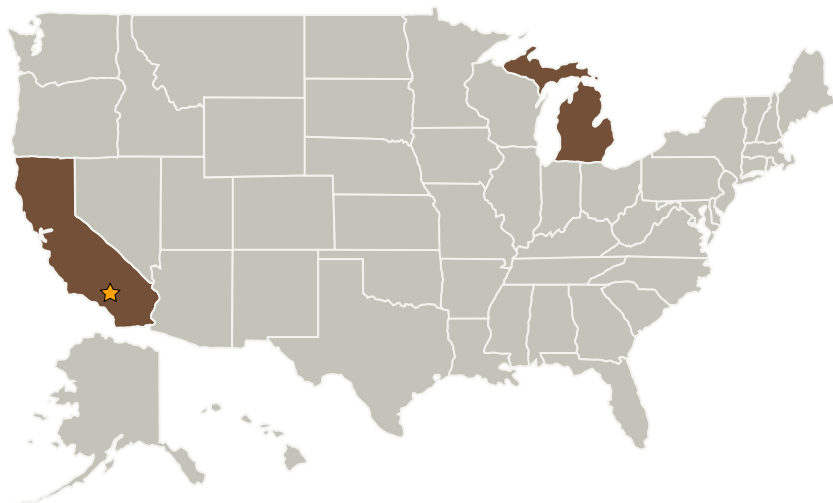
Center Innovation Fund: AFRC CIF

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Armstrong Flight Research Center (AFRC)	Lead Organization	NASA Center	Edwards, California
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations

California	Michigan
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Project Management

Program Director:

Michael R Lapointe

Program Manager:

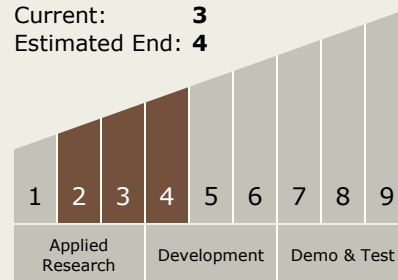
David F Voracek

Principal Investigator:

John J Burken

Technology Maturity (TRL)

Start: 2
 Current: 3
 Estimated End: 4



Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
 - TX11.1 Software Development, Engineering, and Integrity
 - TX11.1.6 Real-time Software

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Images



Vehicle Model

Vehicle Model

(<https://techport.nasa.gov/image/16318>)